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ABSTRACT

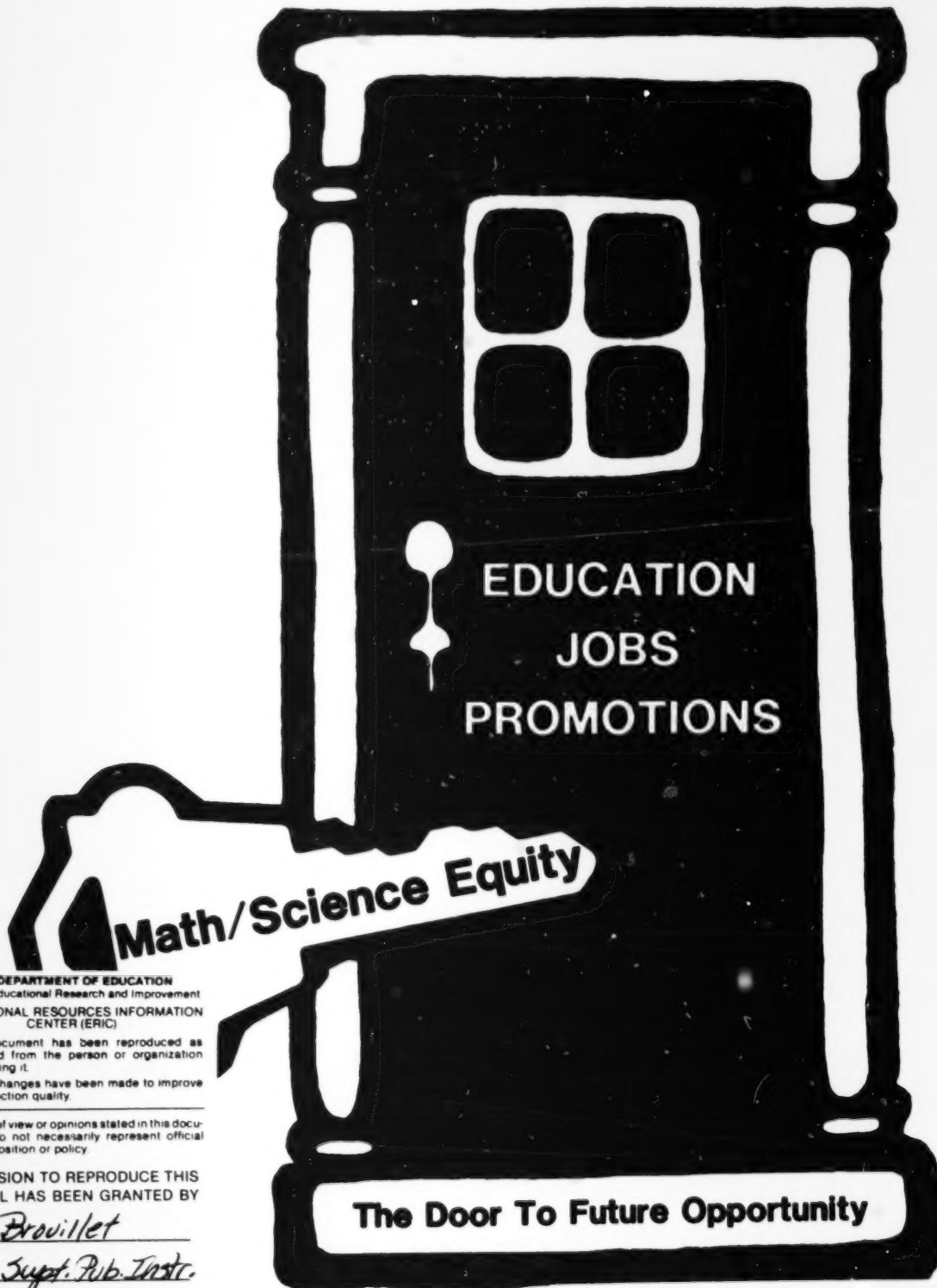
This report on sex equity in mathematics and science education focuses primarily on the situation in Washington State schools. The report is divided into eight sections. Section I explains why the problem is an equity issue: Despite progress in other areas, girls continue to lag behind boys in enrollment and achievement in mathematics and science courses, an indication that biases remain. Section II reviews research in this area and observes that, while girls' interest in mathematics declines as they advance in schools, there is much evidence suggesting that this decline is due to purely environmental factors. Section III provides statistical data on Washington students; girls and boys exhibit equivalent achievement in elementary grades, but questions of equity arise in relation to minority and female enrollments in mathematics and science courses at the secondary level. Section IV presents a form for the use of educators and school administrators in assessing the extent of the problem in their institutions. Section V outlines strategies for change. Section VI summarizes the implications for educators considering intervention efforts. Useful resources are listed in Section VII, and worksheets for district use are provided in Section VIII. (KH)

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Mathematics and Science Equity: Do you have it? How do you get it?

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MATHEMATICS AND SCIENCE EQUITY: DO YOU HAVE IT? HOW DO YOU GET IT?

**A TECHNICAL ASSISTANCE MANUAL FOR ASSESSING, SUPPORTING, AND UNDERSTANDING
MATHEMATICS AND SCIENCE EQUITY IN YOUR SCHOOL DISTRICT.**

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January, 1986

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This manual was developed with the counseling and teaching practitioner in mind.

Prepared by Jill Hearne, this document reflects her deep concern and expertise about the equitable education of girls and young women in the critical areas of mathematics and science. Elden B. Egbers, Supervisor of Mathematics Programs and David A. Kennedy, Supervisor of Science and Environmental Education Programs reviewed this document critically and contributed much to the overall clarification and focus of this challenge for equity in the public schools of Washington State.

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Table of Contents

	Page
I. NATURE OF PROBLEM	
Why is Mathematics and Science Equity an equity issue?	1
II. REVIEW OF LITERATURE	
What do we know about it?	3
III. SITUATION	
What is the extent of the problem in Washington State?	7
IV. BLANK GRAPH FOR SELF-ASSESSMENT	
How does your district/school rate? Checklist for self-assessment	12
V. STRATEGIES FOR CHANGE	
What can you do about inequities in your district/school? .	20
VI. SUMMARY AND IMPLICATIONS	
What are the implications for intervention?	25
VII. RESOURCES	
What help can you get?	31
VIII. WORKSHEETS FOR DISTRICT USE	50

I. NATURE OF PROBLEM

Why is Mathematics and Science Equity an equity issue?

Today, 13 years after the passage of Title IX legislation and 10 years passage of Chapter 28A.85 RCW, our state anti-sex discrimination legislation, there have been great strides in access and increased participation of girls in traditionally male activities. There are competitive and individual sports for girls, coeducational soccer teams and basketball teams in elementary school, and sports scholarships for females at leading universities across the nation. Also, textbooks have changed. Spot may still chase the ball, but Jane is as likely to give him directions as is Dick. Many educators feel secure that their district is providing bias-free education to all participants.

But are they? Are you? What is equity, anyway? The late Ron Edmonds describes equity as "a simple sense of fairness in the distribution of the goods and services that characterize our social order." It is not just access to information, it is participation in and infusion of gender-free activities. A major area still noticeably divided along stereotypical lines is female and minority participation in higher mathematics and mathematics-related science courses; specifically physics, calculus, and computer programming. Correspondingly, there is great disparity in male/female participation in the careers related to mathematics, science, engineering, and technology.

There has been a small improvement over the time period from 1965 to 1980. During this period the proportion of women earning doctorates in science and engineering has risen from 7% to 12%. At

the undergraduate level, the percentage of women earning bachelors degrees in engineering grew from 0.8% in 1970 to 9.7% in 1980, to 14% in 1984. Yet even at this rate, it will be 2020 before there are equal numbers of women and men earning engineering degrees. And what does this have to do with high schools and elementary schools anyway, you may ask?

Nationally, research in this field indicates that mathematics training in secondary schools is a "critical filter" which keeps many students from studying various scientific fields in college. Many entry-level positions in technology today require students to have higher mathematics or computer programming experience in order to be competitive with other applicants. Additionally, the problem solving strategies, conceptual skills and analytical methods employed in computer education, calculus, and physics can be useful in many post-high school settings.

There is good information regarding the reasons females are less likely to pursue higher mathematics, but these reasons should not be excuses for lack of action by individual educators and local districts.



No Thanks !

II. REVIEW OF LITERATURE

What do we know about it?

On the average, girls' enthusiasm for mathematics dwindles as they progress through the grades. Certainly, many high school women (if asked) will tell you that they don't want to take higher mathematics, physics, or computer programming. Responses may range from -- "it's too hard" to "I can't use it." Yet adequately controlled research studies fail to find sex-linked differences which can account for this disparate attitude. Evidence from most studies suggests that parents, teachers and counselors have a powerful influence on students' academic choices. There is also fairly strong

evidence suggesting that students themselves, through their attitudes, self-perceptions, and feelings about mathematics are a major source of the sex differences in both mathematics achievement and course enrollment patterns. Of these factors, confidence in one's ability and the perceived value of math appear to play the most critical roles.

The National Assessment of Educational Progress (1981) continues to find sex-related differences in science and mathematics achievement that result in decreased female participation from age 9 to age 13 to age 17. But there is little evidence that this decline is due to factors other than environmental ones.

For instance, the oft discussed construct of spatial ability appears to account for only 1% to 5% of the variance in cognitive ability. Several researchers have noted lack of consistency in findings, leading Linn and Peterson (1985) to conclude that within-group differences could reflect equally available abilities, while between group differences could reflect unequal experiences.

Current thought stresses the inequality of experiences between girls and boys and targets these experiences for intervention by the school. For instance, consider the following:

- 1) More males than females have science and mathematics related hobbies.
- 2) Males visit science museums more than females.
- 3) Parents design rooms for females differently from those for males.
- 4) Males are more likely to be taught chess and play chess.
Males are likely to be taught by a male.

- 5) Fathers are more likely to help their children with their mathematics homework than are mothers.
- 6) Parents buy more mathematics-related toys for boys than they do for girls.

(Stage et. al, 1985)

There is evidence, as well, that parents, counselors, and teachers provide boys more explicit rewards, encouragements, and reinforcement for learning mathematics and for considering mathematics-related careers than girls. Research studies and anecdotal reports indicate that counselors discourage females and minorities from taking higher mathematics courses. Some teachers, but not all, interact more with, provide more praise to, and provide more formal instruction to boys than to girls, especially in mathematics and science.

These differential experiences appear to be the basis for attitudinal factors which limit female and minority pursuit of higher mathematics skills. As mentioned before, confidence in one's ability and perceived value are the two most critical areas in mathematics enrollment and achievement.

Fennema's "state of the art" review of issues related to women and mathematics indicates that there are three components of the problem:

- 1) participation in mathematics courses in secondary and post secondary years.
- 2) participation in adult mathematics-related occupations.
- 3) achievement or performance in mathematics.

In 1982, the National Council of Teachers of Mathematics held a national conference highlighting participation by women and minorities in mathematics and mathematics-related careers. An Office of the Superintendent of Public Instruction publication: Mathematics Equity summarizes data and presentations from this conference and is available to districts upon request.

Questions of equity in education have evolved from an early concern with access to educational opportunities toward involvement in those areas deemed important for success in our culture. As more stress is placed on knowledge of science and mathematics as an avenue to the expanding field of technological careers, policy makers, educational planners, and teachers need to address the question of equity as it relates to minority and female representation in these areas.

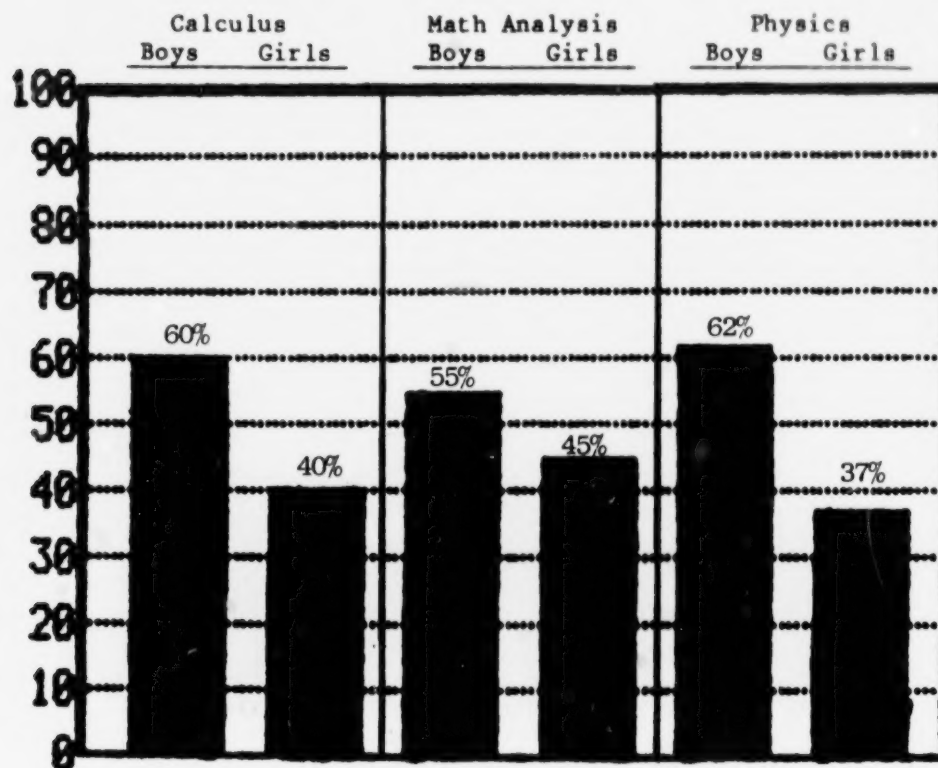
III. SITUATION

What is the extent of the problem in Washington State?

An overview of selected statistics in Washington state provides a framework from which to examine the questions of equity, access, and involvement in science and mathematics as it relates to an individual district.

Despite equivalent mathematics achievement in elementary schools, questions of equity arise in relationship to minority student enrollments in mathematics and science courses at the secondary level (See Table I).

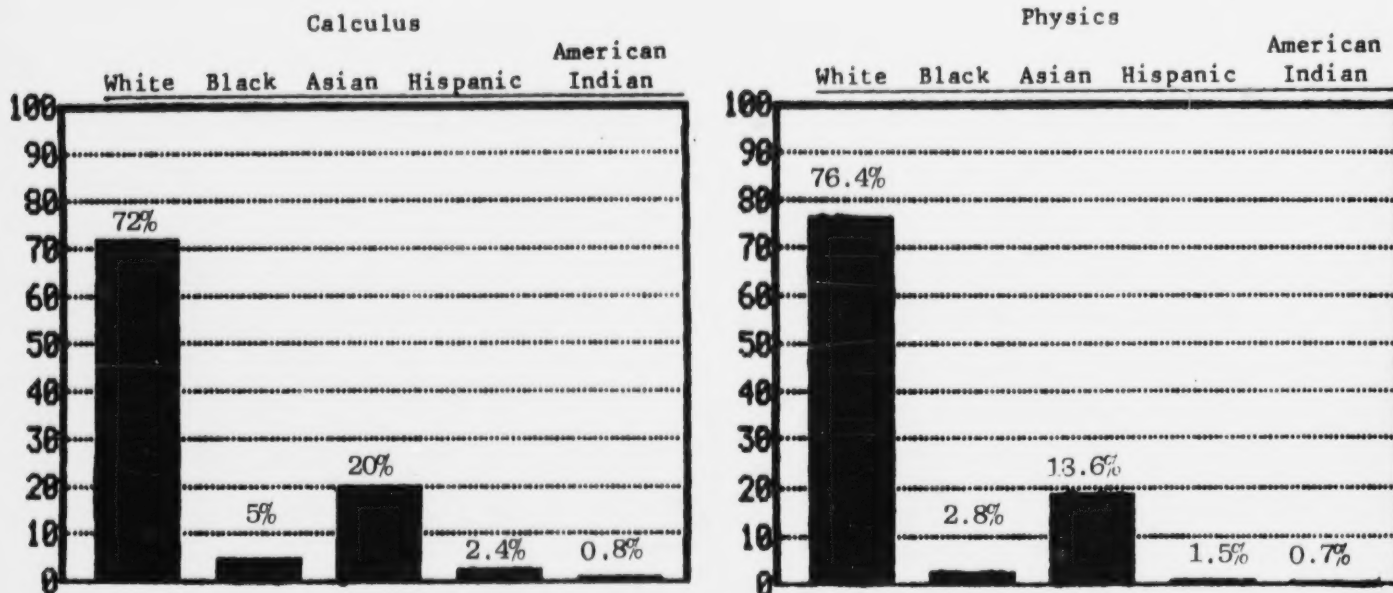
Table I
Percentage Enrollment in Science and Higher Mathematics by Sex
Washington State 1984



An examination of the enrollment patterns by sex indicates noticeably more boys than girls in advanced mathematics classes such as Calculus, Mathematics Analysis, and Trigonometry. Boys are also over-represented in basic mathematics classes such as General, Remedial, or Applied Mathematics. The most notable over-enrollment of girls was in Business Mathematics. In regard to science, Physics enrollment statewide was 63% male and 37% female. Other major science courses, (Biology, Chemistry) were relatively close in their male/female enrollments.

When enrollment in these courses is examined in regard to minority representation there is great disparity in proportions between ethnic groups (See Table II).

Table II
Percent of Total Student Enrollment in Calculus
and Physics in Washington State by Ethnic Group



Again, Asian students are over represented in advanced mathematics and science courses such as Pre-Calculus, Calculus, and Physics. Although Asian students represent only 9.2% of the secondary enrollment studied, approximately 20% of the enrollment in these advanced classes was Asian. Thus, twice as many Asians as would be expected from proportional enrollment projections take Calculus and Physics.

American Indian students were least well represented, with 33% of the expected population taking Calculus and 29% taking Physics, accounting for 0.8% and 0.7% respectively of the total enrollment. Among Black secondary students, 53% enrolled in Calculus and 32% enrolled in Physics, thus accounting for 5% of all Calculus students and 2.8% of all Physics students. Hispanic representation was highest with 64% of the expected enrollment choosing Calculus and 40% choosing Physics or 2.4% and 1.5% respectively. Slightly more Caucasian children enrolled in Calculus and Physics than would be indicated by their overall representation in this student population.

A compiled analysis of a nine year comparison of 4th grade test results statewide revealed significant mathematics achievement gains among all groups. Ethnic groups targeted for assessment were American Indian, Asian, Black, Hispanic, and Caucasian. Overall, from 1976 to 1984 the five selected ethnic groups made gains in mathematics achievement as measured by performance on the California Achievement Test. The percentage of American Indians scoring in the lower quartile (below 25%) on the fourth grade CAT dropped from 34% in 1976 to 19% in 1984. Correspondingly, American Indian students in the upper quartile (above 75%) increased from 14% in 1976 to 26% in 1984. Asian achievement in mathematics increased also, with a 6% drop in the

lower quartile and a 14% gain in students in the upper quartile. Percentages of other ethnic groups scoring below 25% on the CAT dropped similarly: Blacks, 18%, Hispanics, 10%; Whites, 5%. These same ethnic groups reflected an increase in mathematics achievement in the upper 25% range: Blacks 7%; Hispanic, 5%; Whites, 8%. Thus the greatest improvement by group was for American Indians, Blacks and Asians, whose quartile shifts totaled 27, 25, and 20 percentile points respectively.

Participation in the Washington Precollege Testing Program did not vary significantly by ethnic groups over a six year period, 1978-1984. Similarly, participation in the Scholastic Aptitude Test in the state of Washington did not vary over the ten year period (1974-1984) for Blacks (2%), American Indians (1%), Hispanics (1%), and others (1%). Three percent more Asians and three percent fewer Caucasians took the SAT in 1984 than did in 1974.

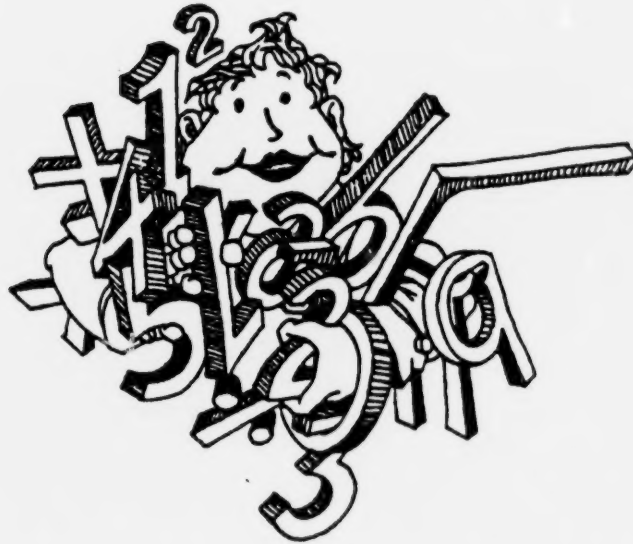
In advance placement programs, Asian students had the highest grades of any ethnic group and the highest percentage enrollment of any of the minority groups. Asian students also took advanced placement examinations in more areas than did any other minority group.

From this data we can make some general observations. First, an overall increase in mathematics achievement levels for all groups studied indicates success of a statewide programmatic focus over the last ten years. Improvement of each minority group's achievement may signal an increase in the qualified pool of potential enrollees in higher mathematics and science courses. Concern must be expressed, however, in assuming that increased mathematics achievement will lead to increased mathematics and science enrollments. This has not proven

to be true for females who, despite achievement in elementary school mathematics and relatively equal enrollments in algebra and geometry classes, do not enroll proportionately in Calculus and Physics.

IV. BLANK GRAPH FOR SELF-ASSESSMENT

How does your district/school rate?



In order to see how your district/school rates in relationship to mathematics equity concerns, use the checklist and graphs to assist you. Current research indicates that the best predictors of success in mathematics are previous math learning and scores on intelligence tests. This self-assessment will provide you with data to discuss issues of equity regarding mathematics and science with your staff.

Checklist for Equity in Mathematics and Science
Adapted from the Mid-Atlantic Center for Race Equity
The American University

(This instrument was inspired by G. Fauth and J. Jacobs, "Equity in Mathematics: The Educational Leader's Role," Educational Leadership 36 (March 1980): 485-490.)

	MATHEMATICS			SCIENCE		
	Yes	No	N/A*	Yes	No	N/A*
A. Starting Out						
1. Have you compared the achievement test data for your minority and female students?	___	___	___	___	___	___
2. Do you have goals which target equity in student participation and performance in mathematics and science?	___	___	___	___	___	___
3. Have you developed a network with other administrators in your district or region who share your goals for female and minority students?	___	___	___	___	___	___
4. Do you have an intervention plan for achieving and maintaining your equity goals?	___	___	___	___	___	___
5. Have you involved your teachers and parents in the development and implementation of the intervention plan?	___	___	___	___	___	___
B. Building Student Support and Positive Self-Concept						
6. Do you have a system for the early identification of all students with high exceptional ability and/or interest in mathematics or science?	___	___	___	___	___	___
7. Have you developed an effective peer support program for female and minority students with exceptional ability and/or interest? (a club, group projects, a special regrouping arrangement, etc.)	___	___	___	___	___	___
8. Does your school provide career education programs which make all students, parents and teachers aware of the importance of studying a minimum of three years of mathematics and science in high school?	___	___	___	___	___	___

*N/A not applicable

	MATHEMATICS			SCIENCE		
	Yes	No	N/A*	Yes	No	N/A*
9. Does your school provide programs and materials to help primary school parents and teachers capitalize on the natural interest and positive attitudes all youngsters have for mathematics and science?	___	___	___	___	___	___
10. Do you provide female and minority role models who are enrolled in school programs or work in careers related to mathematics, science or technology and who demonstrate a high interest in helping all youngsters?	___	___	___	___	___	___
11. Do the children have frequent opportunities to interact with the role models?	___	___	___	___	___	___

C. Instruction

12. Do your mathematics and science programs include effective strategies to address specific academic deficiencies?	___	___	___	___	___	___
13. Does your mathematics program regularly include manipulatives to facilitate the understanding of concepts?	___	___	___	___	___	___
14. Is the science program activity based and student centered, emphasizing the development of science content and process skills?	___	___	___	___	___	___
15. Does your school assume responsibility for providing regular opportunities for minority and female students to master computer concepts?	___	___	___	___	___	___
16. Do you monitor the mathematics and science instructional materials for racism and sexism?	___	___	___	___	___	___
17. Do teachers examine the content of their instructional materials (narratives, pictures, analogies, examples, problems) to determine if there is a bias toward white males?	___	___	___	___	___	___
18. Do you provide instruction for teachers in how to handle bias in instructional materials?	___	___	___	___	___	___

*N/A not applicable

	MATHEMATICS			SCIENCE		
	Yes	No	N/A*	Yes	No	N/A*
19. Are the historical and contemporary contributions of minorities and females in mathematics, science and technology woven into the curriculum?	___	___	___	___	___	___
D. Developing and Training Staff						
20. Have you identified and assisted those teachers who are "math or science anxious?"	___	___	___	___	___	___
21. Have you considered "exchange teaching?" (One solution to the mathematics/science anxiety problem is to have those teachers who enjoy mathematics and science do all of the instruction in those disciplines.)	___	___	___	___	___	___
22. Do you provide and participate in ongoing staff development programs which focus on techniques for making mathematics more interesting?	___	___	___	___	___	___
23. Do you provide and participate in "hands on" workshops which prepare teachers for an activity-based science curriculum?	___	___	___	___	___	___
24. Do you provide staff development programs on teacher expectations and their role in female and minority student achievement?	___	___	___	___	___	___
25. Have you and your staff participated in inservice education programs on cognitive or learning styles?	___	___	___	___	___	___
26. Has your staff used diagnostic instruments which provide information about students' learning styles?	___	___	___	___	___	___
E. Evaluating Your Equity Plan						
27. Do you continuously monitor female and minority student achievement and participation in classrooms and extracurricular mathematics/science activities?	___	___	___	___	___	___
28. Are all students actively participating in classroom discussions, experiments and projects?	___	___	___	___	___	___

*N/A not applicable

	MATHEMATICS			SCIENCE		
	Yes	No	N/A*	Yes	No	N/A*
29. Has there been an increase in female and minority student participation in science fairs and clubs?	—	—	—	—	—	—
	—	—	—	—	—	—
30. Do bulletin boards, book reports and library activities regularly reflect female and minority involvement in mathematics and science (or technology)?	—	—	—	—	—	—
	—	—	—	—	—	—
31. Are more female and minority students enrolling in advanced mathematics and science classes after entering secondary school?	—	—	—	—	—	—
	—	—	—	—	—	—

Data Collection Form #1

Elementary School

Mathematics Achievement Test Data

Directions:

Please fill in achievement test score data by sex, race, ethnic group and grade for your school.

Feel free to modify the headings in the chart so as to make them appropriate for reporting your school's data.

GRADE LEVEL	MEAN SCORE FOR ALL STUDENTS IN THAT GRADE	WHITE STUDENTS		BLACK STUDENTS		HISPANIC STUDENTS		NATIVE AMERICAN STUDENTS		ASIAN STUDENTS		OTHER	
		M	F	M	F	M	F	M	F	M	F	M	F
1													
2													
3													
4													
5													
6													
7													
8													

Name of school _____

Total School Population Data:

	Total # Students	White		Black		Hispanic		Native American		Asian		Other	
		#	%	#	%	#	%	#	%	#	%	#	%
Male													
Female													

Prepared by the Mid-Atlantic Center For Race Equity, The American University

Data Collection Form #2

Elementary School

Science Achievement Test Data

Directions:

Please fill in achievement test score data by sex, race, ethnic group and grade for your school.

Feel free to modify the headings in the chart so as to make them appropriate for reporting your school's data.

GRADE LEVEL	MEAN SCORE FOR ALL STUDENTS IN THAT GRADE	WHITE STUDENTS		BLACK STUDENTS		HISPANIC STUDENTS		NATIVE AMERICAN STUDENTS		ASIAN STUDENTS		OTHER	
		M	F	M	F	M	F	M	F	M	F	M	F
1													
2													
3													
4													
5													
6													
7													
8													

Name of school _____

Total School Population Data:

	Total # Students	White		Black		Hispanic		Native American		Asian		Other	
		#	%	#	%	#	%	#	%	#	%	#	%
Male													
Female													

Prepared by the Mid-Atlantic Center For Race Equity, The American University

Data Collection Form #3

Secondary School

Mathematics/Science Enrollment Data

This survey is appropriate for secondary schools in which optional math and science courses are offered.

Directions:

Examine enrollments in the specified math and science courses. Report numbers and percents by ethnic groups, race and sex of student.

COURSE		TOTAL		WHITE		BLACK		HISPANIC		NATIVE AMERICAN		ASIAN		OTHER	
		#	%	#	%	#	%	#	%	#	%	#	%	#	%
GENERAL MATH (basic skills, consumer math, business math)	Male														
	Female														
	Total														
ALGEBRA I (1st year algebra even if given in more than two semesters)	Male														
	Female														
	Total														
GEOMETRY	Male														
	Female														
	Total														
ALGEBRA II (second year algebra with or without trigonometry)	Male														
	Female														
	Total														
TRIGONOMETRY (analytic geometry, pre-calculus & other advanced math)	Male														
	Female														
	Total														
CALCULUS	Male														
	Female														
	Total														
COMPUTER SCIENCE	Male														
	Female														
	Total														
CHEMISTRY	Male														
	Female														
	Total														
PHYSICS	Male														
	Female														
	Total														
ADVANCED PLACEMENT SCIENCE COURSES	Male														
	Female														
	Total														

Name of school _____

Grades represented in this school _____

Total School Population Data:

	Total # Students	White		Black		Hispanic		Native American		Asian		Other	
		#	%	#	%	#	%	#	%	#	%	#	%
Male													
Female													

This form was adapted by the Mid-Atlantic Center for Race Equity, The American University, from A. Kaseberg, N. Kreinberg, and D. Downie, *Use EQUALS to Promote the Participation of Women in Mathematics* (Berkeley, CA: Lawrence Hall of Science, University of California, 1980), p.59.

V. STRATEGIES FOR CHANGE

What can you do about inequities in your district/school?

There is growing evidence around the United States that active intervention activities at a school and district level can increase female and minority participation in higher mathematics and science classes. Inclusive programs such as PROJECT EQUALS, and MESA--Minority Engineering And Science Achievement, developed at University of California at Berkeley, and "Expanding Your Horizons" developed by Koltnow at Education Development Center, Massachusetts are changing perceptions of teachers, parents, and students around the country. Both of these programs are available in Washington (see Resources section).

Mathematics intervention strategies need to address five areas according to research synthesized by Resta (1985).

1. Curriculum development and revision--Mathematics curriculum should be objectives--based, integrate culturally relevant non-stereotypical material, and focus on real world problem solving skills.
2. Student support services--Counseling programs need to include assertive strategies and support systems for female and minority students with high ability in mathematics and science. Tutorial systems, peer counseling and tutoring, and modeling combine to increase students' perceptions of efficacy in mathematics. Active programs involving women and minorities in scientific fields provide an avenue for dialogue regarding mathematics and science skills.

3. Parent involvement and support--Programs such as Family Math have increased parental awareness of career roles for women and minorities which necessitate additional exposure to mathematics. Parents' expectations and goals are a major consideration in student career choices.
4. Peer support--Active intervention on the part of parents and teachers can reduce students' psychological barriers to achievement in areas perceived as predominantly masculine. As females approach puberty they tend to become uncomfortable about competing in a "male area." Dealing with human aspects of mathematics and science and validating participation and success in mathematics for all students is a key component. Minority students also need to be encouraged to take classes with their friends in key subjects. Counselors need to be aware and recruit for a "critical mass" in higher mathematics and science classes to provide peer support.
5. Faculty support--Staff needs to be committed to equity in access and involvement in mathematics. Stereotypical teaching techniques must be eradicated and the importance of mathematics and science as "critical filters" must be stressed at all grade levels.

Good, Grouws and Elmeier (1983) suggest a step-by-step program for teachers to increase problem solving skills for all students guided by the principles of "active teaching." The four principles are:

- 1) Instructional activity is initiated and reviewed in the context of meaning.

- 2) Students are prepared for each stage of the lesson to increase involvement and to minimize mistakes.
- 3) Distributed and successful practice is built into the program.
- 4) Teaching is "active" i.e. directed.

Other interaction strategies include the following suggestions adapted from Use Equals (1980).

- . Provide time for role models who come to the school to meet with faculty members after their sessions with students. This will increase educators' interest in new and emerging employment opportunities.
- . Hold mathematics/science career conferences for students in one school or district. By focusing specifically on mathematics/science careers, you can present a variety of career information and options to students and educators. For more information on developing a conference of this nature, obtain Expanding Your Horizons in Science and Mathematics, A Handbook for Planners (Appendix C).
- . Organize mathematics/science clubs that include social events as well as participation in mathematics or science activities. Several EQUALS teachers shared their secret of why there were large numbers of female students in their mathematics club: the activities were fun for everyone. They included picnics and potlucks, dances, and field trips. It became socially desirable to be a member of this high school's mathematics club. Programs such as MESA, targeted to increase minority representation in engineering and science, have resulted in increased enrollments, also.

- . Plan discussion groups in which students can air their concern about mathematics and science within the context of the pursuit of popularity. At the high school level, particularly, these social pressures are often a determining factor in whether one is willing to pursue achievement in a male or majority dominated classroom. If a sympathetic and knowledgeable teacher or counselor can establish a support group for these under represented students, much can be accomplished in encouraging them to set high expectations for themselves.

All parents--whether or not they are involved in mathematics and science--should be encouraged to:

- . Provide their daughters with the same kind of toys and games that their sons receive--things to take apart and build, as well as models, puzzles, and games that develop investigative skills.
- . Take their daughters to visit science centers where everyone can actively explore scientific phenomena, and on industry tours (automotive assembly plants, "inside" tours of dams, etc.) so that their daughters can see mathematics and science in action. There may even be an opportunity to see a female role model in a nontraditional career.
- . See that time and space is provided for homework and that the parent takes an interest in the content of the homework and not just its completion.
- . Provide their daughters with magazines and other literature that describe different types of occupations in an interesting manner. Clip newspaper articles on working women and talk about them. Send for career information from large technological industries. The

EQUALS teacher can have a few examples of good, available literature for examination. Perhaps she could prepare a handout to give the parent who could then write for the information.

- . **Become** informed about community resources that are available to stimulate interest in mathematics and science: nature camps, science centers, YWCA, Girl Scouts, Campfire Girls, Sea Scouts, after-school programs at the schools. Most communities have a variety of enrichment activities for students with which parents may be completely unfamiliar.

VI. SUMMARY AND IMPLICATIONS

What are the implications for intervention?

Student and Teacher Related Factors Influencing Female Minority
Student Participation and Performance

FACTORS

IMPLICATIONS FOR INTERVENTION

STUDENTS: AFFECTIVE FACTORS

ATTITUDES

Female and minority students have positive attitudes toward mathematics and science in the early grades.

1. To maintain these attitudes, students must continually be involved in challenging, "hands-on" activities related to their real world. (See Educational Programs.)*
2. They must see others, from a cultural background like theirs, who have maintained this interest in science and mathematics. (See Career Motivation and Professional Organizations.)*

PERSISTENCE

Those who are most successful in mathematics and science have developed the ability to persist. Having the ability to persist in the face of conflict is essentially related to a positive self-concept.

3. To develop this quality, children must be encouraged through the teacher's feedback and guidance to persevere as they work their way through appropriately challenging problems and situations. See Staff Development.
4. They must make decisions, experience success, receive praise and constructive criticism, and recognize the relationship between their decisions, their actions and their success.
5. Teachers may require training in identifying the key elements of persistence and in designing strategies to develop them in children. See Staff Development.

STEREOTYPING

Many teachers tend to stereotype mathematics and science as white male domains.

6. Teachers should introduce models of persons with mathematics and science-related careers. These role models can counteract race and sex stereotyping. (See Career Motivation and Professional Organizations.)*
7. The historical and contemporary accomplishments of females and minorities in mathematics and science must be systematically included in the curriculum. (See Career Motivation.)*
8. Students and teachers must become alert to the presence of race and sex stereotyping in instructional and advertising materials. (See Bias in Instructional Materials.)*
9. Multiethnic television programs developed to provide children with information about science concepts and careers should be used in the classroom and at home to counteract stereotyped images. (See Career Motivation).*

*Appropriate resources are listed in Section VII, "Resources for Intervention."

Adapted from Beane, DeAnna. "Mathematics and Science: Critical Filters for the Future of Minority Students" in 1985 Mid Atlantic Center for Race Equity.

FACTORS

IMPLICATIONS FOR INTERVENTION

	<u>UTILITY</u>
Female and minority students are less likely to understand how the study of mathematics and science is applicable to everyday life, and valuable to their future schooling and jobs.	10. Good counseling by teachers and guidance counselors can provide a realistic picture of the relationship between students' present actions and future course and career options. (See Career Motivation) 11. Exposure to persons who use mathematics and science in the workplace expands female and minority students' awareness of the usefulness of these disciplines. (See Additional Sources) 12. Science and mathematics should be taught in an interdisciplinary manner, enabling students to experience mathematics as an essential tool of science. (See Educational Programs.)* 13. Minority students must have many regular opportunities to use computers for more than drill and practice, computer-assisted instruction, or word processing. Access to computer technology for creative activities increases motivation and awareness of useful applications of mathematics and science. 14. The curriculum should focus on problems, investigations, discussions, trips, and activities designed to integrate mathematics and science skills into the everyday experiences of the students.
	<u>INFLUENCE OF SIGNIFICANT OTHERS</u>
Teachers, counselors, parents and peers have a role in shaping students' attitudes toward mathematics and science.	15. Encouraging female and minority students to take the more challenging educational path conveys a message of confidence in their abilities. (See Career Motivation) 16. Positive, substantive interactions which communicate high expectations can become a self-fulfilling prophecy. 17. Interactions with successful older female and minority students, team-work, peer tutoring and cooperative learning strategies are effective ways to positively utilize peer influence. (See Educational Programs.)* 18. Parent education programs help parents become aware of the importance of mathematics to their children's futures. Such programs should offer suggestions and activities for parents to use in nurturing children's interest in mathematics and science. (See Parent Resources)

*Appropriate resources are listed in Section VII, "Resources for Intervention."

FACTORS

IMPLICATIONS FOR INTERVENTION

STUDENTS: COGNITIVE FACTORS

MISUSE OF TESTING AND TEST DATA

- | | |
|---|--|
| The use of standardized test data to predict achievement and to assess ability is detrimental to minority students. | 30. Tests should be used to determine a child's actual progress rather than his/her disability. (See Bias in Instructional Materials) |
| | 31. Teachers should receive training on the proper use of test data and the purpose of diagnostic, criterion-referenced, norm-referenced and pre- and post-tests. |
| | 32. Student performance on tests must be analyzed and errors examined to identify specific skill and concept deficiencies. |
| | 33. There must be flexibility in grouping. An analysis of errors on practice assignments and tests can be the basis on which flexible groups are formed. Activity-based science and mathematics programs also provide opportunities for flexible, heterogeneous grouping. (See Teaching Resources) |
| | 34. Tests should be culturally fair and should assess the skills and content actually taught. (See Bias in Instructional Materials) |
| | 35. The teaching of test taking skills should be integrated throughout the ongoing curriculum. |

LEARNING STYLES

- | | |
|---|---|
| Instructional strategies frequently do not complement the learning styles of many female and minority students. | 36. Through observations and/or diagnostic assessments, the learning style preferences of students can be determined. |
| | 37. Concept and skill mastery activities should include: manipulatives, experiments, listening, reading, discussion, audiovisuals, movement, practical experiences, group and individual work, contracts, learning centers, writing, role playing, simulations, interviewing, and computers for problem solving. (See Teaching Resources) |
| | 38. Teachers should receive training on teaching styles and learning styles followed by instructional support for developing and implementing alternative instructional strategies such as those cited above. |
| | 39. In regard to computer programming classes, gaming and violence-oriented reward mechanisms should be avoided. (See Educational Programs) |

*Appropriate resources are listed in Section VII, "Resources for Intervention."

FACTORS

IMPLICATIONS FOR INTERVENTION

CLASSROOM FACTORS

TEACHER EXPECTATIONS

Educators often perceive females and minorities as having inferior ability. This perception translates into an expectation of low achievement which is communicated to and internalized by the child. Some also see females as less analytical and less likely to do well in mathematics and science.

39. Honest self-assessment by educators is the first step in breaking this cycle. (See Staff Development.)*
Questions like these must be asked:
- a. Who are my low achievers? (Is there an overrepresentation of female and minority students in this group?)
 - b. How do I relate to females, minorities and low achievers?
 - c. Do I:
 - . Interact more with high achievers or males and ignore and interrupt low achievers or females more frequently?
 - . Ask more and higher level questions of high achievers or males and provide low achievers or females with questions that require only simple recall?
 - . Follow up with probing questions for high achievers or males and call on someone else if a low achiever or female is unable to provide a prompt, accurate response?
 - . Provide a longer wait time for high achievers or males to respond to a question and cut off response time for low achievers or females who hesitate?
 - . Seat high achievers or males closer to the teacher's usual position and cluster low achievers or females further away?
 - . Provide supportive communications for high achievers or males and engage in dominating behaviors with low achievers or females?
 - . Provide high achievers or males with detailed feedback and give less frequent, less accurate and less precise feedback to low achievers or females?
 - . Demand more work and effort from high achievers or males and accept less from low achievers or females?
40. Once a staff is aware of the ways in which expectations are communicated to students, teachers can observe one another's interaction. Individual teachers can then design plans for changing their own behavior in the classroom. (See Staff Development.)*

*Appropriate resources are listed in Section VII, "Resources for Intervention."

FACTORS

IMPLICATIONS FOR INTERVENTION

TEACHER ANXIETY: MATHEMATICS AND SCIENCE

Teachers who do not have positive attitudes about mathematics and science are likely to provide inadequate instruction; additionally, they are poor models for mathematical and science competency and interest.

41. A staff assessment of attitudes toward mathematics will (1) identify teachers experiencing mathematics and science anxiety or avoidance and (2) provide an opportunity for teachers to openly discuss the problem. (See Staff Development)
42. Math-anxious teachers can form a group for discussion and activities designed to change attitudes.
43. Effective inservice programs, tailored to the mathematics and science needs of the local school, can provide teachers with new understandings of content and teaching strategies. (See Staff Development)

TEACHER EXPECTATIONS

Many elementary teachers avoid teaching science because they lack training in science content and science teaching methods, and they have no confidence in their ability to teach it.

44. Confidence and competency can be increased through regular participation in science inservice workshops which offer specific skills, techniques and materials. (See Staff Development)
45. There must be ongoing opportunities to try out new science activities before using them in the classroom. Time should be provided at workshops, faculty meetings or during prearranged preparation time.
46. Professional journals and other materials which focus on elementary school science often combine content and suggested strategies. (See Additional Resources)
47. The development of a supportive network within a district which includes several science teachers from middle or junior high schools and local community should be established.

*Appropriate resources are listed in Section VII, "Resources for Intervention."

There are strategies you can use to improve learning opportunities in mathematics for women and minorities in your district. The time between sixth and eighth grade has been identified as the most critical years for intervention strategies because during those years students form attitudes regarding algebra and higher mathematics.

As an example, the Minneapolis school system developed a mathematics bridge program which identified girls and minority students able to take algebra in high school. These students were invited to participate in a motivational mathematics workshop series on Saturdays. Follow-up activities in high school included ongoing, active encouragement to continue mathematics enrollment, visits to industry, extensive exposure to careers which use mathematics, staff development for teachers to reduce bias, and clear information on the practical utility of each of the mathematics courses offered. These strategies combined have greatly increased participation of women and minorities in mathematical analysis and calculus.

VII. RESOURCES

What help can you get?

These resources are divided into six categories. They are:

- Educational Programs
- Career Motivation
- Bias in Instructional Materials
- Staff Development
- Teaching Resources
- Parent Resources
- Additional Sources

Many of these resources are free. Others can be loaned by the Office of Multicultural/Equity Education at OSPI to interested districts. Some have small fees attached. An attempt has been made to assemble the most useful and most cost effective interventions available.

Educational Programs

AIR Computer Equity Workshop -- This workshop guides participants through a series of activities aimed at self-assessment of equity concerns relative to computer access. Issues addressed include bias in computer software, differential access to computers and peer pressure. No charge to districts. Center for Sex Equity, 800-547-6339 ext. 499.

Blum, Lenore. Expanding Your Horizons in Science and Mathematics. Women's Educational Equity Act Publishing Center, 55 Chapel Street, Newton, Massachusetts 02160. (617/969-7100). (C) 1980. Price (See below.)

Two films and a booklet help educators and parents encourage young women to consider careers in science and technology.

Expanding Your Horizons in Science and Mathematics: A Handbook for Conference Planners describes how to plan, conduct and evaluate conferences to increase a young woman's interest in mathematics and science.

"The Math-Science Connection: Educating Young Women for Today," a film for educators, parents and community leaders, presents four exemplary programs for girls and women who are considering scientific or technical study.

"Sandra, Zella, Dee, and Claire: Four Women in Science," a film for students in grades 7-12, explores the work and lives of an astronomer, a mechanical engineer, a veterinarian and a laser physicist.

- 40006 Expanding Your Horizons: A Handbook for Conference Planners, (50 pp.) \$2.50
The Math-Science Connection: Educating Young Women for Today, 16mm film (color, 18 minutes)
- 40007 Purchase \$115.00
- 40008 Rental (3 days) \$8.00
Videotape cassette (color, 3/4 inch, 18 minutes)
- 40009 Purchase \$32.00
- 40010 Rental (3 days) \$5.00
Sandra, Zella, Dee, and Claire: Four Women in Science, 16mm film (color, 19 minutes)
- 40011 Purchase \$120.00
- 40012 Rental (3 days) \$8.00
Videotape cassette (color, 3/4 inch, 19 minutes)
- 40013 Purchase \$32.00
- 40014 Rental (3 days) \$5.00

Hardeman, Carole. MATHCO: Interdisciplinary Uses of Math in Career Choices: A Curriculum Model. Women's Educational Equity Act Dissemination office, 55 Chapel Street, Newton, Massachusetts 02160. (617/969-7100). (C) 1981. Price \$71.50.

A packet of materials for breaking down stereotypes related to mathematics related careers. The materials are designed for interdisciplinary use in various curriculum areas.

Menard, Sharon. How High the Sky? How Far the Moon? Women's Educational Equity Act Publishing Center, 55 Chapel Street, Newton, Massachusetts 02160. (617/969-7100). (C) 1978. Price \$14.50.

This K-12 curriculum resource guide provides a wealth of activities designed to expand students' interest in scientific and technical careers. Outstanding accomplishments of women in science are highlighted in seven short biographies and supplemented by taped interviews. Extensive information about science careers, and an annotated list of print and audiovisual material for each grade level are provided. (Includes 4 tape cassettes).

MESA - Mathematics, Engineering and Science Achievement, Patricia MacGowan, 353 Loew Hall, Mail Stop FH-18, College of Engineering, University of Washington, Seattle, WA 98195. (206) 543-0562.

MESA is designed to increase the number of underrepresented minorities in mathematics, science, and engineering professions through active intervention classes in junior high and high school.

Use EQUALS to Promote the Participation of Women in Mathematics. Alice Kaseberg, Nancy Krienberg and Diane Downie, Math/Science Network, Lawrence Hall of Science, University of California, Berkeley, California, 1980.

EQUALS is a program that focuses on mathematics avoidance among young women. Included is a workshop model and support materials which are designed to accommodate participants with a variety of mathematical backgrounds, as well as varying amounts of time available for the workshop. While the EQUALS training addresses the special needs of female students, the information is appropriate for males as well. All materials, programs, and resources provided in the training are to be used in whole-class situations, and no students are excluded from the benefits of the program.

Career Motivation

Armstrong, Jane M. Achievement and Participation of Women in Mathematics: An Overview. Education Commission of the States, 1860 Lincoln Street, Suite 700, Denver, Colorado 80295. (303/830-3600). (C) 1980. Price N/A.

A summary of the results of a study by the National Institute of Education on the participation and achievement of girls in mathematics. At the conclusion of the report, strategies are suggested which may increase female participation in mathematics programs. This publication is out of print but available through ERIC. The number is ED187562.

Blum, Lenore. Count Me In: Educating Women for Science and Math. Women's Educational Equity Act Publishing Center, 55 Chapel Street, Newton, Massachusetts 92160. (617/969-7100). (C) 1978. Price \$36.00 (6.00 rental).

This informative thirty-minute videotape is used as a springboard for classroom or workshop discussions about nontraditional career opportunities for women. Through a series of taped vignettes, women of different ages, ethnic backgrounds, mathematical preparation, and career aspirations demonstrate that women can excel in mathematics and science and enter nontraditional fields.

Breyman, Ferol. Beating the Numbers: A Math Careers Program Handbook. Women's Educational Equity Act Publishing Center, 55 Chapel Street, Newton, Massachusetts 02160. (617/969-7100). (C) 1980. Price \$8.00.

This manual describes how to conduct a basic mathematics and counseling program to help undereducated and underemployed women develop basic mathematics skills to increase their job opportunities. The book is a valuable resource for continuing education instructors, career education specialists, counselors and underemployed women. It includes a bibliography of mathematics, counseling, and career information; a sixteen-week lesson plan model; eight counseling workshop models; and occupational mathematics modules for traditional and nontraditional careers.

Business as Usual: Sex Stereotyping in Business Education. Patricia Campbell. Women's Educational Equity Act Program. Washington, D.C. 1979. \$4.50.

This media kit, which includes one 25-minute cassette tape, seven transparency masters, five handouts and a bibliography, explores myths and stereotypes that have limited women in the world of work. It provides suggestions for helping students expand occupational interests and make career decisions that go beyond traditional job aspirations.

Connections: Women and Work and Skills for Good Jobs. Women's Educational Equity Act Program, Education Development Center, Newton, Massachusetts, 1981. \$22.00.

Connections is a multimedia curriculum package designed to introduce middle school students to the world of work, encourage girls to consider careers in nontraditional occupations, and interest boys in supporting girls in their efforts. The Student Gamebook contains activity-oriented lessons and exercises. The Leader's Guide provides background information about women and work, discussion questions, and general implementation suggestions. In Women and Work, the accompanying 20-minute filmstrip, three women (a repairer, an engineer, and a painter) describe the challenge of their work from their perspectives and explain how they prepared for their careers.

Directory of Special Programs for Minority Group Members: Career Information Services, Employment Skills Banks and Financial Aid Sources. Willia L. Johnson, editor. Garrett Park Press. Garrett Park, Maryland. 1980 edition.

The third edition of this directory lists 2,100 general programs, 300 programs supported by Federal agencies, and 2,000 college and university award programs. It includes data on 280 sources of career information, 160 summer employment and internship opportunities, 280 job training programs, and information on hundreds of scholarships, loans, and fellowships. Most of the programs are open only to minority group members.

Emberlin, Diane, Contributions of Women in Science. National Women's History Project, P.O. Box 3716, Santa Rosa, Calif., 95402.

Grades 7-12. This is a collection of women's contributions to world of science.

Expanding Career Horizons. Steiger, Fink and Kosecoff and the Illinois State Board of Education. Springfield, Illinois. 1977.

This curriculum kit contains five 50-minute, activity-oriented lessons. Intended for use by teachers or counselors with students in grades 7-14, the lessons can be used individually or as a complete unit. It is designed to expand students' awareness of career and life options. The lessons include discussions of sex-role stereotyping, laws prohibiting sex discrimination, wages and jobs, cost of living, and guidance tests.

Freedom City. Project Freedom. Middlesex County Educational Services Commission. Piscataway, New Jersey. 1981.

Freedom City was designed by classroom teachers for classroom teachers and was field-tested in grades K-8. One of the main goals of this curriculum packet is to provide the teacher with an easy to use, easily adaptable program dealing with non-sex-stereotyped career education. The packet consists of a teacher's manual, student activity cards and a full set of dittos.

How High Is the Sky? How Far Is the Moon? Sharon L. Menard. Women's Educational Equity Act Program. Newton, Massachusetts. 1979. \$14.50.

This kit is designed to help educators encourage female students to pursue careers in mathematics and the sciences. It includes varied curriculum materials intended for use with K-12 students to increase interest and skill in scientific and technical fields. Extensive information about careers in science, an annotated listing of print and audiovisual materials appropriate for each grade level, and four audiotape cassettes containing interviews with seven women scientists are included.

I Can Be Anything: Careers and Colleges for Young Women. Joyce Slayton Mitchell. College Board Publications. Princeton, New Jersey. 1978.

This book gives job descriptions, requirements and bibliographical resources for 107 careers. It also includes a list of colleges and universities in the United States which offer degrees in the areas mentioned.

It's Her Future. Marilyn Levin. Pennsylvania Commission for Women. Parent Outlook Program. Harrisburg, Pennsylvania. 1981. 16mm color, 17-minute film with discussion guide.

This film and the accompanying fact book encourage parents to support their daughters' efforts to explore nontraditional vocational education programs and careers. Included is information about women in the labor force, current training opportunities and the benefits of pursuing nontraditional careers. Appropriate for counselors, teachers, administrators, and others working to change sex-directed enrollment patterns in vocational education.

Koltnow, J. The Sky's the Limit in Math Related Careers. \$4.75. Order from WEEA Publishing Center, 55 Chapel Street, Newton, MA 02160. (800/225-3088).

The Sky's the Limit demystifies careers that require mathematics skills and encourages women to consider mathematics-related jobs--in laboratories, computer centers, insurance agencies, and government offices. It profiles working women who describe their day-to-day responsibilities, the challenges and rewards of their careers, and the ways in which they combine work and family.

This career booklet explains the training requirements and the opportunities available in fields like computer science, engineering, finance, statistics, and mathematics education, and provides guidelines to help high school students pursue such careers. Reentry women and college and high school students will find The Sky's the Limit inspiring and informative.

Kreinberg, Nancy. I'm Madly in Love With Electricity and Other Comments About their Work. Equals Project, Laurence Hall of Science, University of California, Berkeley, California 94720. (415/642-1823). (C) 1977. Price \$2.00

A career booklet for students in which 70 women discuss aspects of their jobs in science.

Mathematics and Sex. John Ernest. University of California. Santa Barbara, California. 1976.

This book examines equal opportunity in mathematical education (training and counseling). It includes a discussion of student attitudes, observations on inadequate mathematics training for women, and recommendations for remedying those inadequacies.

McLenighan, Valjean. Women and Science. National Women's History Project, P.O. Box 3716, Santa Rosa, Calif., 95402. \$12.95.

Grades 4-7, biographies of women scientists.

Minority Contributors I. Minorities in Engineering Project, National Coordinating Center for Curriculum Development, State University of New York at Stony Brook. Available from Ginn Custom Publishing, 191 Spring Street, Lexington, Massachusetts. (617/861-1670). (C) 1980. Price \$1.50.

This publication highlights the careers of minority mathematicians, scientists and engineers. It is a good resource for secondary students who may be considering such careers. Included are interviews with the individuals in which they share their perspectives toward their work.

Minority Contributors II. Minorities in Engineering Project, National Coordinating Center for Curriculum Development, State University of New York at Stony Brook. Available from Ginn Custom Printing, 191 Spring Street, Lexington, Massachusetts. (617/861-1670). (C) 1980. Price. \$1.50.

This publication is similar to Minority Contributors I; however, its emphasis is on Hispanic, Indian, and Asian American scientists, mathematicians and engineers.

Nonsexist Counseling: Helping Women and Men Redefine Their Roles. Cecelia H. Foxley. Kendall/Hunt Publishing Company. Dubuque, Iowa. 1979.

The main purpose of Nonsexist Counseling is to help counselors, counselor educators, and others in the helping professions become more aware of the detrimental effects of sex-role stereotyping and to provide them with models, programs, suggestions, and activities they can use in working with a wide variety of clients including girls, boys, women and men who find themselves living in a time of rapidly changing roles.

Nontraditional Careers for Women. Pathescope Educational Films and the Associated Press. New Rochelle, New York. 1974. Two filmstrips, two cassette tapes and a teacher's manual.

The Careers program has been designed to offer students the opportunity to learn about a variety of careers in relation to their aptitudes, interests, experiences, needs and dreams and to discover that decisions they make now will have an impact on their entire lives. Designed for use with junior and senior high school students.

Options: A Career Development Curriculum for Rural High School Students.

Faith Dunne, Peter Kelman, Janet Bailey, and Joyce Weingart.
Dartmouth College. Hanover, New Hampshire. 1980.

This program is designed to provide high school students with the information and problem-solving skills needed to make career and life-planning decisions.

Osen, Lynn M. Women in Mathematics. The M.I.T. Press, Massachusetts Institute of Technology, 28 Carleton Street, Cambridge, Massachusetts 02142. (617/253-2884). (C) 1974. Price \$4.95.

A historical review of the impact women have had on the development of mathematical thought. It explores the lives of women who have made significant contributions, and delves into the social context within which they worked.

Perl, Teri. Math Equals: Biographies of Women Mathematicians and Related Activities. Addison-Wesley Publishing Company, Jacob Way, Reading, Massachusetts 01867. (617/944-3700). (C) 1978. Price \$8.95.

The book explores the lives of a number of women who have made significant contributions to mathematics. It also includes mathematics activities in the context of the work in which they were involved.

Self Administered Survey of Sex Stereotypes for Project MASSIVE. Ohio Department of Education, Division of Guidance and Testing, 65 South Front Street, Room 719, Columbus, Ohio 43215.

This survey is machine scoreable and allows respondents to examine their perceptions regarding sex stereotyping. The purpose is to help people become more conscious of their views and expectations about male and female characteristics and functions related to careers. By being more conscious of their views and expectations, respondents can become aware of possible stereotyping behaviors that might result.

Ward, Susan G. Looking Out the Window. Susan G. Ward, developer. Utah State Office of Education, Salt Lake City, Utah. September, 1980.

Looking Out the Window is designed to provide students with an opportunity to explore careers. It uses cassette tapes, hand puppets, pictures and discussion questions in an exploration in which both boys and girls can learn the skills which are needed to enter these careers. By using nonsexist names, the cassette tapes and puppets avoid stereotyping careers as being "only for boys" and "only for girls" and emphasize that success is dependent upon acquiring the necessary skills. Appropriate for use with preschool through fifth-grade-level students.

Bias In Instructional Materials

Guidelines for Selecting Bias-Free Textbooks and Story Books. Council on Interracial Books for Children, 1841 Broadway, New York, New York 19923. (212/757-5339). (C) 1979. Price \$6.95.

This resource provides a guide for selecting instructional materials. It contains components in all the major curriculum areas including science and mathematics.

Handbook I and II Guidelines for the Development of Instructional Materials Selection Policies, Office of the Superintendent of Public Instruction. No charge.

Help Wanted--Sexism in Career Education Materials--How to Detect It and How to Counteract Its Effects in the Classroom. Women on Words and Images. Princeton, New Jersey. 1975.

This report summarizes research on sex bias in career education materials. It provides documentation on the existence of sex-role stereotyping found in samples of K-12 and postsecondary career education materials, offers general advice to teachers and counselors for detecting and counteracting sexism in those materials currently in classroom use, presents a teacher/counselor activity checklist for enriching career opportunity awareness, and lists organizations and products which are considered nonsexist sources and resources.

Issues of Sex Bias and Sex Fairness in Career Interest Measurement. Esther Diamond. Department of Health, Education and Welfare. Washington, D.C. Spring, 1975.

This study continues the examination of sex fairness and sex bias in career interest inventories initiated in professional organizations and journals. It presents a variety of ideas for practical use by those concerned with vocational-interest testing.

Teacher Inservice Staff Development

Count Me In: Educating Women for Science and Math. Mills College.
Women's Educational Equity Act Program. Newton, Massachusetts. 1978.
30-minute black and white videotape (3/4" U-matic). \$36.00 purchase,
\$6.00 rental.

This videotape documents a comprehensive curricular/career model program at Mills College designed to help women enter scientific and technical fields. Many elements of the program can be adapted for use at other educational levels and types of institutions. It is appropriate for high school teachers, counselors and administrators, as well as high school students and parents.

Equality in Science: Formula for Changing Sex Bias. Women's Educational Equity Act Publishing Center, 55 Chapel Street, Newton, Massachusetts 02160. (617-969-7100). (C) 1979. Price \$4.50.

The effects of stereotyping on student interest and ability in science are addressed in this inservice module. The contributions of women to science are discussed, along with ideas for activities in science classes and in the community.

Fennema, Elizabeth. Multiplying Options and Subtracting Bias. Order from National Council of Teachers of Mathematics, 1906 Association Drive, Reston, VA 22091. (703) 620-9840. 1981.

A videotape and workshop intervention program designed to eliminate sexism from mathematics education. Four 30-minute, full-color videotapes, narrated by Marlo Thomas, each for a specific junior/senior high school audience, uses a variety of formats--candid interviews, dramatic vignettes, and expert testimony--to address the problem of mathematics avoidance and suggest some possible solutions. A 192-page facilitator's guide provides an overview of the workshops, detailed instructions on how the facilitator can prepare for conducting the workshops, and four separate step-by-step sets of workshop instructions for each of the target audiences. 1981.

Each Videotape & A Guide	\$125.00
Students #303	Parents #304
Teachers #305	Guidance Counselors #306
All Four Videotapes & A Guide	#307 \$375.00
Specify tape size when ordering	
3/4" Videotape, BETA-1, 1/2" Open Reel & VHS	

Good, T. L., Grouws, D., and Ebmeier, Active Mathematics Teaching, 1983.
Center for Research in Social Behavior, 111 East Stewart Road,
University of Missouri, Columbus, MO 65211.

This book includes a step-by-step program for teachers to increase problem solving skills for all students through "active teaching." The four principles are: 1) instructional activity is initiated and reviewed in the context of measuring, 2) students are prepared for each stage of the lesson to increase involvement and to minimize mistakes, 3) distributed and successful practice is built into the program and 4) teaching is "active", i.e. directed.

Math/Science Network, Nothing But Options, c/o Mills College, Oakland, CA 94613. Purchase \$240, Rental \$40.

17½ minute award winning videotape and discussion guide which profiles five young career women whose jobs represent a range of choices available to young women with a strong mathematics/science base. These careers are:

- environmental science
- computer systems analysis
- electrical engineering
- computer graphics
- financial investments

Sex Stereotyping in Math Doesn't Add Up. Women's Educational Equity Act Publishing Center, 55 Chapel Street, Newton, Massachusetts 02160. (617/969-7100). (C) 1979. Price \$4.50.

This learning module covers sex differences in mathematics ability, the ways in which stereotyping limits mathematics skill development, how students' decisions about mathematics affect future career choices, and how teachers can help students to develop their mathematics skills. The module contains a 30-minute audiotape cassette, instruction sheet for leaders, handouts for participants, bibliography and transparency masters.

Teacher Resources

Beyond Equals, Math/Science Resource Center, Mills College, Oakland, CA 94613. \$10.00.

This 149 page fully illustrated book extends the EQUALS work to adults by providing effective strategies for teaching the foundations of mathematics and deductive reasoning skills to adult learners.

Brown, Janet W. Native American Contributions in Science, Engineering, and Medicine. Science Magazine, Volume 189, July 4, 1975, pp 38-40.

This article is one of the few resources available for raising teacher awareness of Indian contributions and perspectives toward the sciences.

Downie, Diane, Slesnick, Twila and Stenmark, Jean Kerr. Math for Girls and Other Problem Solvers. Math/Science Network. Lawrence Hall of Science. University of California, Berkeley, California. 1981.

The content of this manual focuses on problem solving, rather than on traditional arithmetic skills, and is designed to involve students and teachers in thinking about problem solving in new ways and forms. The problems require mental and physical activity and encourage creative thinking by asking for and allowing nonstandard problems and solutions. While the original course on which this book is based was designed to reverse the pattern of mathematics avoidance by girls, these activities are appropriate for both boys and girls, ages six to fourteen.

Fraser, Sherry, SPACES, Solving Problems of Access to Careers in Engineering and Science, 1982, Laurence Hall of Science, University of California, Berkeley, CA 94720.

This is a practical curriculum guide with reproducible lessons designed to stimulate student's thinking about scientific careers, develop problem solving skills, and promote positive attitudes toward the study of mathematics.

Haber, Louis. Black Pioneers of Science and Invention. Harcourt Brace Johanovich, 757 Third Ave., New York, New York. (212/888-4444). (C) 1973. Price \$6.75.

A good resource for teachers who want to integrate information on minority scientists and mathematicians into their curriculum.

Hayden, Robert C. Eight Black American Inventors. Addison Wesley Publishing Co., Jacob Way, Reading, Massachusetts 01867. (617/944-3700). (C) 1976. Price \$6.95.

A collection of biographies of Black Americans who have contributed original inventions. It is best suited for junior and senior high school students.

Hayden, Robert C. and Harris, Jacqueline. Nine Black American Doctors. Addison Wesley Publishing Co., Jacob Way, Reading, Massachusetts 01867. (617/944-3700). (C) 1976. Price. \$6.95.

This publication includes biographies of Black Americans who have contributed to the field of medicine. It is written for grades 6-12 and is an excellent resource for the teacher who wants to integrate the contributions and perspectives of Black Americans into the science curriculum.

Hayden, Robert C. Seven Black American Scientists. Addison Wesley Publishing Co., Jacob Way, Reading, Massachusetts 01867. (617/944-3700). (C) 1970. Price \$6.95.

A collection of biographies of Black American scientists. It is best suited for junior and senior high school students.

Kasburg, Alice; Kreinberg, Nancy and Downie, Diane. Use Equals To Promote the Participation of Women in Mathematics. Equals Project, Laurence Hall of Science, University of California, Berkeley, California 94720. (415/642-1823). (C) 1980. Price \$5.00.

A handbook for sex-fair mathematics and career counseling methods. Includes materials for both the elementary and secondary educators.

Kogelman, Stanley and Warren, Joseph. Mind Over Math. The Dial Press, 1 Dag Hammarskjold Plaza, New York, New York 10017. (212/832-7300). (C) 1978. Price \$3.95.

This book was written by two prominent mathematicians based on their experiences in leading groups to help people overcome mathematics anxiety. It provides some interesting insights and strategies for teachers who may notice the symptoms of this ailment in themselves or their students.

Kojima, Takashie. The Japanese Abacus, Its Use and Theory. C. Tuttle Co., Japanese American Curriculum project, 414 East Ave., P.O. Box 367, San Mateo, California. (415/343-9408). (C) 1954. Price \$3.25.

This book includes the theory behind the abacus as well as instructions for its use. It also includes problems and exercises.

Mitchell, Merle, Mathematical History, Activities, Puzzles, Stories, and Games. Order from National Council of Teachers of Mathematics. 1978. ISBN 0-87353-138-8. \$267. \$5.00.

Imaginative puzzles and games based on stories of famous mathematicians, numerals of ancient people, and even numerology to enliven the study of mathematics in the middle grades; removable activity pages suitable for duplicating.

Mizmura, K. If I Were A Cricket. T.Y. Crowell Co. Available through the Japanese American Curriculum Project, 414 East Third Ave., P.O. Box 367, San Mateo, California 94401. (415/343-9408). (C) 1973. Price \$7.95.

A primary science book with outstanding artwork which adds a multicultural flavor to science.

Sprung, Barbara, Campbell, B., and Frosche, M. What Will Happen If... Young Children and the Scientific Method.

The activities in this guide foster visual-spatial and problem-solving skills and provide strategies to ensure that all children develop these essential skills from the beginning of the educational experience. The guide takes familiar components of the early childhood classroom and expands them to explore mathematic and scientific concepts in age-appropriate ways. In Water and Sand, children make and use sieves to explore the concept of flow. In Bottles and Liquids, children use their senses to explore the concepts of density and viscosity. In the Block activities, children build ramps to

explore momentum and extrapolate data from their results. WHAT WILL HAPPEN IF... also helps children understand technology in the world around them. In Machines and Me, children learn about machines, computers, and technology in general by making books and collages, going on trips, taking things apart, and putting them back together. \$10.95. Order from Educational Equity Concepts, Inc., 440 Park Avenue South, New York, NY 10016.

Streeter, Tal. The Art of the Japanese Kite. Weatherhill Publishing Co. Available through the Japanese American Curriculum Project. 414 East 3rd Ave., San Mateo, California. (415/343-9408). (C) 1974. Price \$9.95.

The book includes the history and traditions of Japanese kite-making. It also includes a detailed "How To" section. It could be used for projects related to flight and aerodynamics.

The Great Black Inventors' Calendar. Miller Brewing Company, Great Black Inventors' Calendar, P.O. Box 7815, Westbury, New York 11592. Price \$2.25.

This calendar features posters of famous Black Inventors. It would be very useful for adding a multicultural flavor to bulletin boards and the classroom environment.

Tobias, Sheila. Overcoming Math Anxiety. W.W. Norton & Co., 500 5th Ave., New York, New York. (212/354-5500). (C) 1978. Price \$10.95.

An excellent resource for the classroom teacher who is interested in developing a strategy for working with students who come to the mathematics classroom with great apprehension.

Vecsey, Christopher and Venables, Robert W. American Indian Environments: Ecological Issues in Native American History. Syracuse University Press, 1011 East Walter St., Syracuse, New York. (315/423-2596). (C) 1980. Price \$9.95.

A collection of writings on the historical and contemporary relations between Native Americans and their environment. It is a teacher resource for integrating cross-cultural concepts into Biology and Environmental Science programs.

Yep, Laurence. Dragon Wings. Harper Row Publishing Co. Available through Japanese American Curriculum Project, 414 East 3rd Ave., San Mateo, California. (415/343-9408). (C) 1977. Price \$1.95.

An award winning novel based upon facts about a Chinese who made a flying machine during the Wright era.

Parent Resources

Family Math, Northwest Equals Oregon Museum of Science and Industry, 4015 S.W. Canyon Road, Portland, OR 97221.

This excellent program consists of 6 sequential workshops which aim at demystifying mathematics for parents and students. In a game-like setting parents and students work together to develop problem-solving skills.

Moursand, David, Parent's Guide to Computers in Education, 1984, Eugene: International Council for Computers in Education.

This easy to use reference guide gives parents practical suggestions on what to do at home to help children with computers. A buyer's guide for hardware and software is included.

Sugar and Spice Is Not the Answer: A Parent Handbook on the Career Implications of Sex Stereotyping. Louise Vetter, Cheryl Meredith Lowry and Carolyn Burkhardt. The Center for Vocational Education, Ohio State University, Columbus, Ohio. 1977.

This book discusses how children's career options are limited by sex stereotyping, why it is important that they not be limited, and what parents can do about it.

The Time Has Come. Third Eye Films. Cambridge, Massachusetts. 1980. 16mm color film.

This film, designed for parents, explores how elements inside the home can be made less stereotyped and less limiting for both sexes. It also deals with influences outside the home, such as school and television.

Additional Resources

Association for Women in Science

Office of Opportunities in Science

1776 Massachusetts Ave. N.W.

Washington, D.C. 20036 (202) 467-5438

Gender Expectations/Student Achievement

GESA Project Manager - Dolores A. Grayson, 213/922-6910

GESA Office - Los Angeles County Office of Education

Division of Project Funding and Management, Room 246

9300 East Imperial Highway

Downey, CA 90242-2890

GESA is designed to enable classroom teachers to identify and improve their interactions with students. Following each workshop, the teachers observe in each other's classrooms, coding (by gender) teacher-student interactions which were studied at the workshop. During each unit, teachers are also provided with the resources to address a curricular issue in their classrooms. Improvement in basic skill achievement for all student participants has been noted.

Interface Consultants

7080 S.W. Firloop, Suite 200

Portland, OR 97223

Linda Davenport, (503) 684-0514

This group provides technical assistance and staff development at no charge to qualifying districts.

Northwest Equals - Oregon Museum of Science and Industry, 4015 S.W. Canyon Rd., Portland, Oregon 97221, Madeline Moore, (509) 222-2828.

Provides Inservice programs designed to attract and retain women and minority students in mathematics, science, and technology.

Pacific Science Center, 200 2nd Ave. N., Seattle, WA 98109, Education Registrar, (206) 433-2001.

"Science on Wheels" (K-6)

A portable exhibit and series of science and mathematics lessons for elementary students. Throughout the day, classes explore the interactive exhibits set up in the library or gymnasium during 30 minute blocks. Popular exhibits include electrical circuit boards, Targrains, globoards, and a magnetism display. Fee: \$300/10 lessons.

"Star and Snakes" (K-6)

This all day program brings unique science lessons to your school. Pacific Science Center teachers instruct ten-fifteen 45 minute classes. Teachers of primary students (K-3) choose animal lessons which make use of a live boa constrictor. An inflatable planetarium is used to teach intermediate students how to use a star map. Fee: \$300/ten lessons.

Computer Van (K-12)

This program brings 3 instructors and fifteen Apple computer systems to your school. Once set up, ten 45 minute lessons per day can be taught using PSC equipment. Lessons are tailored for K-12 grade levels and topics range from beginning to advanced. Fee: \$320/10 lessons.

Society of Women Engineers (SWE)

Pacific Northwest Section, P.O. Box 12320, Seattle, WA 98111

Pres: Pat Kishline, (206) 631-4059
Chris Haynes, (206) 524-4777

Eastern Washington Chapter

Ann Langevin, President

6075 West Van Giesen
West Richland, WA 99352
(509) 376-7337

Marsha Bell

Rockwell Hanford Operations
2752 - 200 E., P.O. Box 800
Richland, WA 99352
(509) 373-2183

This organization has a Career Guidance Committee which provides speakers. They also give out scholarships and certificates of merit to achieving students.

Weyrick, Joanne - Eastern Washington Director, MESA
Tri-Cities University Center, 100 Sprout Road, Richland, WA 99352
(509) 375-3176

Contact for Expanding Your Horizons and MESA in Eastern Washington.

Women in Mathematics

Jerine Ridgeway
Mathematics
South Seattle Community College
6000 16th Ave. S.W.
Seattle, WA 98106
SCAN 628-5371
(206) 764-5371

Through this organization a complementary Speakers Bureau of Women in Mathematics is available to school districts.

Another program sponsored by SSCC is Math Olympiad, an annual contest for grades 4 through 9. Volunteer schools send teams for competition at the South Seattle Campus.

References

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- Linn, M. C. and Peterson, A. C., "Facts and Assumptions about the Nature of Sex Differences" in Handbook for Achieving Sex Equity Through Education, ed. by Susan S. Klein, 1985, Baltimore: Johns Hopkins Press, p. 53-78.
- Resta, P. "Multicultural Mathematics" presentation at "Achieving Quality Through Equity" Conference sponsored by Chief Council of State School Officers. Seattle, WA., June 1985.
- Sells, Lucy. "High School Mathematics as the Critical Filter in the Job Market," proceedings of the conference on Minority-Graduate Education, University of California, Berkeley, May 1973.
- Stage, E., Kreinberg, N., Eucles, J., and Becker, J. "Increasing the Participation and Achievement of Girls and Women in Mathematics, Science, and Engineering" in Handbook for Achieving Sex Equity Through Education ed. by Susan G. Klein, 1985, Baltimore: Johns Hopkins Press, p. 237-268.
- Tyree, E., Newman, J., Motomatsu, N., Egbers, E., Dallas, S., Mathematics Equity, 1983, KNOW-NET, Office of the Superintendent of Public Instruction, Olympia, WA.

I056QL.00

VIII. WORKSHEETS FOR DISTRICT USE

	Algebra I		Calculus	
	<u>Girls</u>	<u>Boys</u>	<u>Girls</u>	<u>Boys</u>
100				
90				
80				
70				
60				
50				
40				
30				
20				
10				

*Note: to calculate % divide the total for the group into the number enrolled.

Example: 12 males and 3 enrolled = $3 \div 12 = \underline{\hspace{1cm}}$ or 25%.

	Physics		Word Processing		Computer Programming	
	<u>Girls</u>	<u>Boys</u>	<u>Girls</u>	<u>Boys</u>	<u>Girls</u>	<u>Boys</u>
100						
90						
80						
70						
60						
50						
40						
30						
20						
10						

Algebra ICalculus

American				
White	Black	Hispanic	Indian	Asian
90				
80				
70				
60				
50				
40				
30				
20				
10				

American				
White	Black	Hispanic	Indian	Asian
90				
80				
70				
60				
50				
40				
30				
20				
10				

Word ProcessingComputer Programming

American				
White	Black	Hispanic	Indian	Asian
90				
80				
70				
60				
50				
40				
30				
20				
10				

American				
White	Black	Hispanic	Indian	Asian
90				
80				
70				
60				
50				
40				
30				
20				
10				

Physics

White Black Hispanic American Indian Asian

90
80
70
60
50
40
30
20
10

Self-assessment checklist

1. Where are your computers located?

____ library ____ business ed. ____ math dept. ____ other



—DR. FRANK B. BROUILLET—

Superintendent of Public Instruction

Old Capitol Building, FG-11, Olympia, WA 98504

IPS/603/86